

# **Importation of Papaya Fruit, *Carica papaya*, from Nicaragua into the Continental United States**

## **Qualitative, Pathway-Initiated Pest Risk Assessment**

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## A. Introduction

This pest risk assessment was prepared by the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture (USDA) to examine plant pest risks associated with the importation into the United States of **fresh fruits of papaya (*Carica papaya*) grown in Nicaragua**. This is a qualitative pest risk assessment, that is, estimates of risk are expressed in qualitative terms such as high or low rather than numerical terms such as probabilities or frequencies. The details of methodology and rating criteria can be found in: *Pathway-Initiated Pest Risk Assessment: Guidelines for Qualitative Assessments, version 4.0* (USDA, 1995); available from the individual named in the proposed regulations, or on the web site: [www.aphis.usda.gov/ppq/bats/bant](http://www.aphis.usda.gov/ppq/bats/bant).

International plant protection organizations, e.g., North American Plant Protection Organization (NAPPO) and the United Nations Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analyses. The methods used to initiate, conduct, and report this plant pest risk assessment are consistent with guidelines provided by NAPPO and FAO. Our use of biological and phytosanitary terms conforms with the *NAPPO Compendium of Phytosanitary Terms* (Hopper, 1996) and the *Definitions and Abbreviations* (Introduction Section) in *International Standards for Phytosanitary Measures, Section 1—Import Regulations: Guidelines for Pest Risk Analysis* (FAO, 1996).

The *Guidelines for Pest Risk Analysis* provided by FAO (1996) describe three stages in pest risk analysis. This document satisfies the requirements of FAO Stages 1 (initiation) and 2 (risk assessment).

## B. Risk Assessment

### 1. Initiating Event: Proposed Action

This pest risk assessment is commodity-based, and therefore "pathway-initiated"; the assessment is in response to a request for USDA authorization to allow importation of a particular commodity presenting a potential plant pest risk. In this case, the importation of **fresh fruits of papaya (*Carica papaya*) grown in Nicaragua** is a potential pathway for introduction of plant pests. Regulatory authority for the importation of fruits and vegetables from foreign sources into the U.S. is found in 7 CFR §319.56 .

## 2. Assessment of Weediness Potential of Papaya, *Carica papaya*

The results of the weediness screening (Table 1) did not prompt a pest-initiated risk assessment.

**Table 1: Process for Determining Weediness Potential of Commodity**

**Commodity:** *Carica papaya* L. (papaya) (Caricaceae)

**Phase 1:** *Carica papaya* is grown commercially in Florida, Hawaii, and Puerto Rico. Papaya is also grown in greenhouses throughout the United States, primarily as a curiosity.

**Phase 2:** Is the species listed in:

- NO *Geographical Atlas of World Weeds* (Holm *et al.*, 1979)
- NO *World's Worst Weeds* (Holm *et al.*, 1977)
- NO *World Weeds, Natural Histories and Distribution*, (Holm *et al.*, 1996)
- NO *Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act* (Gunn and Ritchie, 1982)
- NO *Economically Important Foreign Weeds* (Reed, 1977)
- NO Weed Science Society of America list (WSSA, 1989)
- NO Is there any literature reference indicating weediness (*e.g.*, AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "species name" combined with "weed").

**Phase 3: Conclusion:**

*Carica papaya* is grown for commercial and other purposes throughout the United States and the scientific literature provided no indication of weediness potential.

### 3. Previous Risk Assessments, Current Status, and Pest Interceptions

#### 3a. Decision history for *Carica papaya* from Central America

- 1971 - Costa Rica: permitted entry subject to fumigation or adequate processing in lieu of treatment.
- 1990- Panama: denied entry, no acceptable treatment for medfly.
- 1993 - Guatemala: denied entry, lack of treatment facilities in Guatemala.
- 1995 - Belize: permitted entry subject to treatment as a condition of entry or from a medfly free area.
- 1997 - Panama: pest risk assessment completed, no management decision.

#### 3b. Pest interceptions from 1985-1998 from Central America

Country	Pest	Part	Total
Belize	<i>Blapstinus sp.</i>	Fruit	1
Belize	<i>Dicrepidius sp.</i>	Fruit	1
Belize	Elateridae, species of	Fruit	1
Belize	<i>Phyllophaga sp.</i>	Fruit	1
Belize	<i>Pseudococcus sp.</i>	Fruit	1
Belize	Pseudococcidae, species of	Fruit	3
Costa Rica	<i>Anastrepha sp.</i>	Fruit*	1
Costa Rica	<i>Cryptomenus bergi</i>	Fruit	1
Costa Rica	Diaspididae, species of	Leaf	1
Costa Rica	<i>Listronotus sp.</i>	Fruit	1
Costa Rica	<i>Paragonatus costaricensis</i>	Fruit	1
El Salvador	Coccidae, species of	Fruit	1
Guatemala	Agromyzidae, species of	Fruit	1
Guatemala	Coccidae, species of	Leaf	1
Guatemala	Diaspididae, species of	Fruit	1
Guatemala	Tortricidae, species of	Fruit	1
Panama	Aleyrodidae, species of	Leaf	1
Panama	Coccidae, species of	Leaf	1
Panama	Lepidoptera, species of	Fruit	1

\* Interception taken from fruit carried in baggage.

#### 4. Pest List: Pests Associated with *Carica* spp.

The pest list in Table 2 was developed after a review of the information sources listed in USDA (1995). The list summarizes information on the distribution of each pest, pest-commodity association, and regulatory history.

<b>Table 2: Pest List - <i>Carica</i> spp.</b>			
<b>Scientific Name, Classification</b>	<b>Distribution<sup>1</sup></b>	<b>Comments<sup>2</sup></b>	<b>References</b>
<b>Pathogens</b>			
<i>Asperisporium caricae</i> (Spegazzini) Maugblanc (Fungi Imperfecti: Hyphomycetes)	NI,US	c,f,o	CMI, 1972; Farr <i>et al.</i> , 1989; USDA, 1998
<i>Botrytis cinerea</i> Pers.:Fr. (Fungi Imperfecti: Hyphomycetes)	Worldwide	c,f,o,v	CMI, 1974a; Farr <i>et al.</i> , 1989; Wellman, 1977
<i>Calonectria crotalariae</i> (C.A. Loos) D.K. Bell & Sobers (Pyrenomycetes: Hypocreales)	US, Warm-temperate and tropical regions	a,o,v	Farr <i>et al.</i> , 1989
<i>Choanephora cucurbitarum</i> (Berk. & Ravenel) Thaxt. (Zygomycetes: Mucorales)	US, Temperate to tropical regions	a,c,o,v	Farr <i>et al.</i> , 1989
<i>Colletotrichum gleosporioides</i> (Penz.) Penz. and Sacc. In Penz. (Fungi Imperfecti: Coelomycetes)	CZ,US	c,f,o,v	Farr <i>et al.</i> , 1989; Wellman, 1977
<i>Corynespora cassicola</i> (Berk. & M.A. Curtis) C.T. Wei (Fungi Imperfecti: Coelomycetes)	CZ,US	c,f,o,v	Wellman, 1977
<i>Erysiphe cichoracearum</i> D.C. (Pyrenomycetes: Erysiphales)	Worldwide	c,o,v	CMI, 1967a; Farr <i>et al.</i> , 1998
<i>Fusarium solani</i> (Mart.)Sacc. (Fungi Imperfecti: Hyphomycetes)	Worldwide	c,o,v	CMI, 1964a; Holliday, 1980
<i>Phoma</i> (=Ascochyta) <i>caricae</i> (Pat.) Punithalingam	NI,US(HI)	o	McGuire and Crandall, 1967
<i>Phyllosticta caricae-papayae</i> Allesch. (Fungi Imperfecti: Coelomycetes)	FL, subtropical and tropical regions	a,o,v	Farr <i>et al.</i> , 1989
<i>Phytophthora capsici</i> Leonian (Oomycetes: Peronosporales)	CZ,US	c,o,v	CMI, 1985
<i>Phytophthora nicotianae</i> Brea de Haan var. <i>parisitica</i> (Dastur) G.M. Waterhouse (Oomycetes: Peronosporales)	CZ,US	c,f,o,v	CMI, 1964b

<i>Phytophthora palmivora</i> (E.J. Butler) E. J. Butler (Oomycetes: Peronosporales)	NI,US	c,o	Farr <i>et al.</i> , 1989; McGuire and Crandall, 1967
<i>Pythium aphanidermatum</i> (Edson) Fitzp. (Oomycetes: Peronosporales)	CZ,US	a,c,o,v	CMI, 1964c, Farr <i>et al.</i> , 1989
<i>Pythium ultimum</i> Trow (Oomycetes: Peronosporales)	US, Cosmopolitan	a,c,o,v	Farr <i>et al.</i> , 1989
<i>Pythium vexans</i> de Bary (Oomycetes: Peronosporales)	US, Cosmopolitan	o,v	Farr <i>et al.</i> , 1989
<i>Rhizoctonia solani</i> Kuhn (Fungi Imperfecti: Agonomycetes)	Worldwide	a,c,o,v	CMI, 1974b; Farr <i>et al.</i> , 1989
<i>Rhizopus stolonifer</i> (Ehrenb.:Fr.) Vuill. (Zygomycetes: Mucorales)	Worldwide	b,c,o,v	CMI, 1977, Farr <i>et al.</i> , 1989
<i>Sclerotium rolfsi</i> Sacc. (Fungi Imperfecti: Agonomycetes)	NI,US	a,c,o	CMI, 1992
<i>Septoria caricae</i> Speg. (Fungi Imperfecti: Coelomycetes)	CZ	a,v	Wellman, 1977
<i>Sphaerotheca fuliginea</i> (Schlechtend.Fr.) Pollacci (Pyrenomycetes: Erysiphales)	Worldwide	c,f,o,v	CMI, 1967b, Farr <i>et al.</i> , 1989
<i>Stemphylium lycopersici</i> (Enjoji) W. Yamamota (Fungi Imperfecti: Hyphomycetes)	CZ,US	o,v	CMI, 1975, Farr <i>et al.</i> , 1989
<b>Bacteria</b>			
Papaya bunchy top disease (unidentified bacteria)	NI,US	f,o	Davis <i>et al.</i> , 1996; Krochmal, 1974
<b>Viruses</b>			
Papaya ringspot virus	NI,US	f,o	Ploetz <i>et al.</i> , 1994
Tomato spotted wilt tospovirus	Worldwide	f,o	Brunt <i>et al.</i> , 1996
<b>Arthropods</b>			
<i>Aconophora femoralis</i> Stal. (Homoptera: Membracidae)	NI	a	Maes, 1988; McGuire and Crandall, 1967
<i>Aleurocanthus woglumi</i> Ashby (Homoptera: Aleyrodidae)	NI,US	h	EPPO, 1995; FAO, 1993; Mound and Halsey, 1978; USDA, 1998

<i>Anastrepha fraterculus</i> complex (Wiedemann) (Diptera: Tephritidae)	NI	*Z <sub>q</sub>	Borge and Basedow, 1997; Malavasi <i>et al.</i> , 1995, Baker <i>et al.</i> , 1944; Steck, 1991; Steck and Sheppard, 1993; Stone, 1942
<i>Anastrepha ludens</i> (Loew) (Diptera: Tephritidae)	NI	*Z <sub>n</sub>	Borge and Basedow, 1997; USDA, 1998; White and Elson-Harris, 1992
<i>Anastrepha obliqua</i> (Macquart) (Diptera: Tephritidae)	NI	*Z <sub>m</sub>	Borge and Basedow, 1997; White and Elson-Harris, 1992
<i>Anastrepha serpentina</i> (Wiedemann) (Diptera: Tephritidae)	NI	*Z <sub>n</sub>	Borge and Basedow, 1997
<i>Anastrepha striata</i> (Loew) (Diptera: Tephritidae)	NI	*Z <sub>n</sub>	Borge and Basedow, 1997
<i>Aphis gossypii</i> Glover (Homoptera: Aphidae)	NI,US	c,f,o	Blackman and Eastop, 1984
<i>Bemisia tabaci</i> (Gennadius) (Homoptera: Aleyrodidae)	NI,US	c,f,o	USDA, 1998
<i>Ceratitis capitata</i> (Wiedemann) (Diptera: Tephritidae)	NI,US <sup>3</sup>	Z <sub>o</sub>	USDA, 1998; White and Elson-Harris, 1992
<i>Conchaspis angraeci</i> Cockerell (Homoptera: Coccidae)	NI,US	c,o	Ben-Dov, 1981; Mamet, 1954
<i>Eotetranychus lewisi</i> McGregor (Acari: Tetranychidae)	NI,US	c,o	EPPO, 1995; Jeppson <i>et al.</i> , 1975
<i>Erinnyis ello</i> (L.) (Lepidoptera: Sphingidae)	NI,US	c,o	Hodges <i>et al.</i> , 1983; McGuire and Crandall, 1967
<i>Ferrisia virgata</i> Cockerell (Homoptera: Coccoidea)	NI,US	c,o	Ben-Dov, 1994; CIE, 1966
<i>Hypothenemus crudiae</i> (Panzer) (Coleoptera: Scolytidae)	NI,US	a,o	Maes and Equihua, 1988, Poole and Gentili, 1996
<i>Hypothenemus eruditus</i> Westwood (Coleoptera: Scolytidae)	NI,US	a,o	Maes and Equihua, 1988; Poole and Gentili, 1996
<i>Hypothenemus paralellus</i> (Hopkins) (Coleoptera: Scolytidae)	NI	a	Maes and Equihua, 1988
<i>Hypothenemus hampei</i> (Ferrari) (Coleoptera: Scolytidae)	NI	a	Maes and Equihua, 1988

<i>Macrosiphum euphorbiae</i> (Thomas) (Homoptera: Aphidae)	NI	c,f,o	Blackman and Eastop, 1984
<i>Milviscutulus mangiferae</i> (Nietner) (Homoptera: Coccidae)	NI,US	c,o	Ben-Dov <i>et al.</i> , 1975
<i>Myzus persicae</i> (Sulzer) (Homoptera: Aphidae)	NI,US	c,f,o	Blackman and Eastop, 1984
<i>Nipaecoccus nipae</i> (Maskell) (Homoptera: Coccoidea)	NI,US	c,o	Ben-Dov, 1994
<i>Parasaissetia nigra</i> (Nietner) (Homoptera: Coccidae)	NI,US	c,o	Ben-Dov, 1978; EPPO, 1995
<i>Philephedra tuberculosa</i> Nakahara and Gill (Homoptera: Coccidae)	NI,US	o	Nakahara and Gill, 1985
<i>Polyphagotarsonemus latus</i> Banks (Acari: Tarsonemidae)	NI,US	c,o	CIE, 1986
<i>Rhynchophorus palmarum</i> (Linne) (Coleoptera: Curculionidae)	NI	a	McGuire and Crandall, 1967
<i>Tetranychus desertorum</i> Banks (Acari: Tetranychidae)	NI,US	o	Jeppson, <i>et al.</i> , 1975
<i>Toxotrypana curvicauda</i> Gerstaecker (Diptera: Tephritidae)	NI,US	o <sup>4</sup> (except HI),z	Borge and Basedow, 1997, White and Elson-Harris, 1992
<i>Xyleborus volvulus</i> (Fabricius) (Coleoptera: Scolytidae)	NI,US	a,c,o	Maes and Equihua, 1988; Poole and Gentili, 1996

<sup>1</sup> Distribution legend: NI = Nicaragua; US = United States; HI = Hawaii

- <sup>2</sup> Comments:
- a = Pest mainly associated with a plant part other than the commodity.
  - b = Not likely to be a primary plant pest.
  - c = Listed in USDA's non-reportable dictionary as non-actionable.
  - f = Pest occurs in the U.S. and is not subject to official restrictions and regulations.
  - h = Quarantine pest: pest has limited distribution in the U.S. and is under official control as follows: (1) pest listed by name in USDA's pest dictionary, official quarantine action may be taken on this pest when intercepted on this commodity and, (2) pest is a program pest.
  - o = Organism does not meet the geographic or regulatory definition of a quarantine pest.
  - v = No specific reports of the pest from the country of export, but regional reports exist and the pest may be present in the country of export.
  - z<sub>i</sub> = Internal pest: is known to attack or infest and it would be reasonable to expect the pest may remain with the commodity during process and shipping.
  - z<sub>m</sub> = Laboratory infestations only.
  - z<sub>n</sub> = Not considered a regulatory host although a few rare interception records, most likely backyard and/or ripe fruits.
  - z<sub>s</sub> = This complex is of the Mexican-Central American population and does not have the host range as the *A. fraterculus* species in South America.
  - z<sub>o</sub> = Papaya is considered to be a poor host for med fly.

<sup>3</sup> *Ceratitis capitata* has been detected on occasion in the United States. Whenever *C. capitata* has been detected, a quarantine was established and an eradication program was implemented. *C. capitata* is considered a quarantine pest in the United States.

<sup>4</sup> *Toxotrypana curvicauda* is not considered a quarantine pest in the continental U. S. It is considered a quarantine pest for Hawaii and host material is prohibited.

\* The fruit flies, *Anastrepha fraterculus*, *A. ludens*, *A. obliqua*, *A. striata* and *Ceratitis capitata* have been reported to attack papaya in some countries and they occur in Nicaragua. Studies conducted in Costa Rica on papaya from April 1986 until August 1990 (Lara *et al.*, 1989; Lara, 1990) on *Ceratitis capitata* and four species of *Anastrepha*, *A. fraterculus*, *A. obliqua*, *A. serpentina*, and *A. striata* document that papaya is not a good host. None of the fruits were infested when subjected to natural infestations in the field at the commercial harvesting ripeness index or slightly above (0, 1, 2, and 3).\*\*

In forced field infestations studies, even under relatively high insect pressure conditions, none of the five species infested papaya at or below harvesting ripeness index 2. *A. striata* did not infest at all at any ripeness index. *A. obliqua* and *A. fraterculus* infested only fruits at index 5, and to a very low level *i.e.* *A. obliqua* - 17 pupae were recovered from 30 fruits at ripeness index of 5, only 3 adults emerged.

*A. serpentina* was successfully reproduced in papayas at ripeness index of 4. In another test, using a laboratory reared strain that had been reared for 5, 6, 7 consecutive generations in papaya fruit at ripeness index 3 and 4, adults were recovered from fruit with a ripeness index of 1. It may be that the fruit fly colony was already favorably conditioned to the ripeness index. In these studies the laboratory-reared strain infested papaya fruit significantly more than the wild strain.

Research (Malavasi *et al.*, 1995) in Brazil to determine host susceptibility of “solo” papaya to *Ceratitis capitata* and *Anastrepha fraterculus* documented similar results.

The *Anastrepha fraterculus* species in of the Mexican - Central American population (Stone, 1942; Baker *et al.*, 1944; Steck, 1991; Steck and Sheppard, 1993) and does not have the host range as the species of *A. fraterculus* in South America discussed by Malavasi *et al.*, 1992. According to the authors listed above *A. fraterculus* represents a complex of species.

*A. ludens* was not included in these tests but based upon PPQ’s many years experience with imported Mexican papaya it appears that on rare occasions overripe fruits may be attractive to species of *Anastrepha*.

The absence of a significant number of *Anastrepha* interceptions from commercial and non commercial papaya despite our many years experience with this fruits provides further documentation that the fruits does not serve as a normal host in nature for *Anastrepha*. PPQ does not considered papaya to be a host of *Anastrepha* spp. and based on the information presented above we conclude that commercial shipments of papaya from Nicaragua does not pose a threat of introducing *Anastrepha* spp.

#### **\*\*Color scale**

- 0 = mature green, fully grown fruit with 100% dark green peel
- 1 = color break, actual yellow color over not more than 20% of total surface and surrounded by light green
- 2 = approximately one quarter of surface light yellow to firm yellow surrounded by light green
- 3 = up to one-half of surface yellow with neighboring areas light green turning yellow
- 4 = over one-half of the surface yellow with neighboring areas light green turning yellow
- 5 = full yellow or the proximal end green to light green

## 5. List of Quarantine Pests

The list of quarantine pests for commercial shipments of papaya from Nicaragua is provided in Table 3. Should any of these pests be intercepted on commercial (or any other) shipments of *Carica papaya* quarantine action may be taken.

Table 3: Quarantine Pests:	
Arthropods	<i>Aleurocanthus woglumi</i> <i>Ceratitis capitata</i> <i>Toxotrypana curvicauda</i>

## 6. Quarantine Pests Likely to Follow Pathway

Only those quarantine pests that can reasonably be expected to follow the pathway, *i. e.*, be included in commercial shipments of *Carica papaya*, were analyzed in detail (USDA, 1995). Only quarantine pests listed in Table 4 were selected for further analysis and subjected to steps 7-9 below.

Table 4: Quarantine Pest Selected for Further Analysis:	
Arthropods	<i>Ceratitis capitata</i>

Other plant pests in this Assessment, not chosen for further scrutiny, may be potentially detrimental to the agricultural production systems of the United States; however, there were a variety of reasons for not subjecting them to further analysis. For example, they are associated mainly with plant parts other than the commodity; they may be associated with the commodity (however, it was not considered reasonable to expect these pests to remain with the commodity during processing); they have been intercepted as biological contaminants of these commodities during inspections by Plant Protection and Quarantine Officers but would not be expected to be present with every shipment. In addition, the biological hazard of organisms identified only to the generic level are not assessed due to the lack of adequate biological/taxonomic information. This lack of biological information on any given insect or pathogen should not be equated with low risk. By necessity, pest risk assessments focus on those organisms for which biological information is available. By developing detailed assessments for known pests that inhabit a variety of niches on the parent species, *i.e.* on the surface of or within the bark/wood, on the foliage, etc., effective mitigation measures can be developed to eliminate the known organism and any similar unknown ones that inhabit the same niches.

## 7. Economic Importance: Consequences of Introduction

The consequences of introduction were considered for each quarantine pest selected for further analysis. For qualitative, pathway-initiated pest risk assessments, these risks are estimated by rating each pest with respect to five risk elements (USDA, 1995). Table 5 shows the risk ratings for these risk elements.

Table 5: Risk Rating: Consequences of Introduction						
Pest	Climate/ Host	Host Range	Dispersal	Economic	Environ- mental	Risk Rating
<i>Ceratitidis capitata</i>	high	high	high	high	high	high

## 8. Likelihood of Introduction

Each pest is rated with respect to introduction potential, *i.e.*, entry and establishment. Two separate components are considered. First, the amount of commodity likely to be imported is estimated. More imports lead to greater risk; therefore, the risk rating for the quantity of commodity is the same for all quarantine pests considered. Second, five biological features, (risk elements) concerning the pest and its interactions with the commodity are considered. The resulting risk ratings are specific to each pest. The cumulative risk rating for introduction was considered to be an indicator of the likelihood that a particular pest would be introduced (USDA, 1995). Table 6 shows our ratings for these risk elements.

Table 6: Risk Rating: Likelihood of Introduction							
Pest	Quantity of commodity imported annually	Likelihood survive postharvest treatment	Likelihood survive shipment	Likelihood not detected at port of entry	Likelihood moved to suitable habitat	Likelihood find suitable host	Risk rating
<i>Ceratitidis capitata</i>	medium	high	high	high	high	high	high

## 9. Conclusion: Pest Risk Potential and Phytosanitary Measures

The measure of pest risk potential combines the risk ratings for consequences and likelihood of introduction (USDA, 1995). The estimated pest risk potential for each quarantine pest selected for further analysis for the importation of *Carica papaya* is provided in Table 7.

Table 7: Pest Risk Potential, Quarantine Pests	
Pest	Pest risk potential
<i>Ceratitidis capitata</i>	high

Plant pests with a high Pest Risk Potential may require specific phytosanitary measures. The choice of appropriate sanitary and phytosanitary measures to mitigate risk is undertaken as part of Risk Management and is not addressed, *per se*, in this document.

PPQ has many plant pest interceptions from papaya from other areas; however, virtually all external pests listed could be detected by inspection. Some of these same pests occur in Nicaragua in addition

to other quarantine pests and have been intercepted as hitchhikers with other commodities. Should any of these pests be intercepted on commercial (or any other) shipments of *Carica papaya*, quarantine action may be taken.

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